DEPARTMENT OF COMMERCE

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OF THE BUREAU OF STANDARDS

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CONTENTS

INTERNATIONAL COMPARISON OF RADIO-FREQUENCY STANDARDS

The increase in power of many United States and foreign radio stations, making them international in their effects, has raised the question as to whether or not the national standards of radio-frequency of the various governments are in agreement. Since 1924, the bureau has made several comparisons of frequency standards with the national laboratories of England, France, Italy, Germany, Canada, and Japan. These showed satisfactory agreement to the accuracy then required.

During the past year, however, it has become important to know much more accurately the agreement of the standards of the different nations. The development of the temperature-controlled piezo oscillator offered a means of attaining this. Accordingly, during the summer of 1927 the chief of the bureau's radio section took to Europe such a piezo oscillator containing two quartz plates which were carefully calibrated according to the United States standards. The piezo oscillator was so constructed that the conditions of operation (tube voltages, temperature, etc.) could be very accurately reproduced at any place. Measurements were made on these piezo oscillators at the National Physical Laboratory, England; Military Telegraph Laboratory, France; Italian Naval Laboratory, Italy; and the National Physical and Technical Laboratory, Germany, where the national

standards of the respective countries are maintained.

The differences between the measurements made at the various laboratories were very small, the average departures from the mean being 3 parts in 100,000. This agreement is surprisingly good. It represents an average difference of only 0.03 kilocycle at 1,000 kilocycles (300 meters). This is much smaller, for instance, than the variation, 0.5 kilocycle, allowed broadcasting stations in this country. In other words, so far as the United States and these four countries are concerned the national standards of frequency agree sufficiently well to insure against interference, provided the transmitting stations are accurately adjusted according to their national standards.

TESTING AND ADJUSTING PIEZO OSCILLATORS

By order of the Federal Radio Commission broadcast stations are required to maintain their frequency within 500 cycles (0.5 kilocycle) of their assigned value. To maintain this accuracy of adjustment it is necessary to have special apparatus for checking the frequency of the transmitting set. The only satisfactory devices at present available for this are piezo oscillators, piezo resonators, and automatic piezo control. A piezo oscillator using a quartz plate is a very satisfactory device and can be purchased commercially. Specifications for a portable piezo oscillator are given in Bureau of Standards Letter Circular No. 186. The piezo oscillator described in these specifications does not provide for maintaining the quartz plate at constant temperature, which is desirable for the highest accuracy. These specifications do not include directions for cutting and grinding the quartz plate. A suitable plate can be obtained commercially. Letter Circular No. 223 describes the use of piezo oscillators in radiobroadcasting stations. (Copies of these letter circulars may be obtained by persons having actual use for them by addressing the Bureau of Standards, Washington, D. C.)

When a piezo oscillator used as a standard to aid in maintaining the frequency of a station is tested by the Bureau of Standards, there are certain conditions which must be fulfilled. The bureau will undertake a test of a piezo oscillator only upon written request of the owner or operator of the transmitting station in which the piezo oscillator is to be used. This request must contain the following information: (a) Name of the owner of the station where the piezo oscillator is to be used, (b) location and call letters of the station, (c) licensed frequency of the station, (d) type of piezo oscillator and quartz plate used.

There is just at present an exceptional demand for radio tests of this kind which is greatly in excess of the capacity of the bureau for immediate service. For this reason it has been necessary to schedule pending tests and to notify each applicant for test of the approximate date the test will be made. Tests already scheduled will require about two months to complete. Every effort is being made to give much quicker service, consistent with accuracy, after that time.

Assignment of a date for test will be made only upon receipt of the written request from the owner or operator of the station giving the required information. The apparatus may be shipped at the time the test is requested or later in time to reach the bureau a few days before the assigned date. The test requires not less than two days to complete. It is necessary that the entire piezo oscillator except tubes and batteries be sent to the bureau. The type of tubes and the voltages should be specified in the letter requesting test.

The quartz plate must have a frequency not more than 1 per cent below the licensed frequency. If it has a frequency higher than the licensed frequency, it can not be adjusted by grinding. The fee for adjustment of quartz plates with mechanical means for adjustment is $12. The fee for quartz plates which are not provided with a

mechanical means for adjustment and which must, therefore, be adjusted by grinding is $20. In case it is desired to maintain the quartz plate at a constant-controlled temperature higher than room temperature, the work involved in the test is much greater. The fees for such tests are $25 and $50, depending on the type of adjustment required.

LARGE DISK OF OPTICAL GLASS COMPLETED

On January 21 the mold containing the large disk of optical glass, cast by the Bureau of Standards on May 7, 1927, was opened and the glass found to be very good. It appears to be quite uniform throughout, and although it contains some seeds and striæ, they will not affect its value as a telescope mirror.

The cover was removed in the presence of several distinguished scientists, including Dr. S. W. Stratton, president of Massachusetts Institute of Technology; W. R. Warner, of the firm of Warner & Swasey, internationally known telescope makers; and Dr. George K. Burgess, Director of the Bureau of Standards.

The disk, which is about 70 inches in diameter, 11 inches thick, and weighs 3,500 pounds, will be used as a great concave mirror for the new reflecting telescope of the Perkins Observatory at Ohio Wesleyan University, Delaware, Ohio.

The money with which to establish this observatory was left to the university by Prof. Hiram Mills Perkins, of Ohio Wesleyan, who during 50 years of hard work through most rigid economy and sound investment had been able to amass a small fortune, nearly a quarter of a million dollars. It was his desire to establish an observatory of the first rank at the university and that the entire equipment be of American manufacture. The mounting of the telescope was constructed by the famous American telescope makers, Warner & Swasey, of Cleveland, Ohio, but difficulty was experienced in getting any bids on the mirror from American glass manufacturers. In particular, no one was willing to state, even approximately, when the disk could be completed. Finally the director of the observatory, Dr. Clifford C. Crump, called upon the Department of Commerce for assistance. Although the Bureau of Standards has been making optical glass since 1914, no task approaching the magnitude of the present one had ever been attempted.

After four unsuccessful attempts to obtain a disk of the size required a unique method was developed by the bureau's glass section. Cullet (broken glass of the same composition as the glass to be made) to the amount of 1,000 pounds and 4,600 pounds of sand and chemicals were melted in a single large pot in a gas-fired furnace. The percentage composition of the ingredients used was as follows:

	Per cent		Per cent
Sand	49.90	Barium carbonate	1.86
Boric acid	4.40	Saltpeter	6.57
Borax	17.55	Zinc oxide	1.86
Soda ash	5.69	Arsenic	.30
Potash	11.97		

The molten glass was stirred by hand for six hours, and at the proper time on May 7, 1927, the pot was tapped. The glass was flowed into a mold of the required size which was specially designed for this purpose by the bureau. The mold was at the same time a carefully insulated annealing furnace, provided with electrical heating elements, by means of which the temperature could be adjusted and controlled to within a degree.

The temperature of the glass when poured was about 1,350° C. For one week the temperature was slowly lowered until it reached 600° C. The glass was held at this point for about four days to allow the temperature of the glass and furnace to become uniform throughout. At 600° C. this particular kind of glass (borosilicate crown) is quite rigid and yet sufficiently viscuous to yield to cooling stresses without danger of cracking.

Beginning on May 18 the glass was allowed to cool slowly at an average

rate of 2½° C. per day till 460° C. was reached. It was then annealed at this temperature for six weeks, during which time no variation greater than 1° C. was permitted. Final cooling was started on August 30, and room temperature was attained on January 16. The furnace was opened on January 21, and the disk was found to be of excellent quality.

The experience gained for the bureau's scientific staff will be of inestimable advantage, not only to the bureau, but to any American glassmakers who may wish to profit by the data obtained, which the bureau hopes to publish in the near future.

ULTRA-VIOLET TRANSMISSION OF GLASSES AND GLASS SUBSTITUTES

The number of inquiries which the bureau has received concerning the ultra-violet transmission of glasses and glass substitutes appears to justify the reprinting of the latest (third) edition of Letter Circular No. 235 on this subject in the Technical News Bulletin. The text of this letter circular is as follows:

This letter circular is issued in response to numerous inquiries for information on the transmissive properties of new glasses and organic substitutes for window glass for use in solariums, sun parlors, schools, homes, office buildings, animal houses, and greenhouses.

The visible rays of light are comprised between the approximate wave lengths of 760 millimicrons in the red and 400 millimicrons in the violet. Wave lengths longer than 760 millimicrons are called infra-red and those shorter than 400 millimicrons ultra-violet. Though the average eye is not sensitive to wave lengths shorter than 400 millimicrons, such rays actually exist in the light of the sun, extending down to a wave length a little more or a little less than 300 millimicrons, depending on the time of day, season of year, latitude, altitude, and clearness of atmosphere.

Since ordinary window glass shuts out the ultra-violet rays below about 310 millimicrons, much attention has been given of late to the production of special glasses, transparent to the shortest wave lengths which the atmosphere permits the sun to furnish us. This letter circular gives the results of ultra-violet transmission tests which have been made at the Bureau of Standards upon a number of such special glasses and common window glass.

Total transmission of various glasses for those ultra-violet solar rays to which common window glass is opaque.—Using a filter method, direct measurements, with sunlight as source, have been made during the noon hours of especially clear days from April to December, 1927.

These measurements covered the solar spectral region to which common widow glass is opaque (below about 310 millimicrons). Table 1 gives for that region the total transmission found for the following specimens:

TABLE 1.—*Total transmissions of various glasses when new, for the ultra-violet solar rays to which common window glass is opaque*

Trade name	Transmission	Trade name	Transmission
	Per ct.		*Per ct.*
Fused quartz	92	Cel-o-glass [1]	20
Corex	92	Quartz-lite	5
Helioglass (Vioray [1])	50	Flexoglass [2]	1
Vitaglass	50	Common window glass	0-5

[1] Vioray is the foreign trade name for Helioglass.
[2] This consists of a fine wire screen whose interstices are covered with cellulose acetate.
[3] This is a loosely woven fabric usually covered with paraffin.

Spectral transmissions of various glasses for the ultra-violet rays.—A second and more reliable method of measuring the relative transparency of a specimen of glass to ultra-violet light is to determine its spectral transmission curve, wave length by wave length. Curves of this description are shown in the accompanying illustration.[1] These curves were obtained by means of an artificial source of light (quartz mercury arc) giving a line spectrum richer in ultra-violet than the solar spectrum.

By means of these spectral transmission curves an estimate of the relative transmissions of the various specimens for rays shut out by common window glass may be obtained by reading from the curves the values of the transmission at 302 millimicrons—the wave length of an intense mercury line of convenient value for making such tests. Table 2 gives transmission values for this wave length. These are our most recent findings for new specimens.

[1] The chart accompanying the letter circular is necessarily omitted.

TABLE 2.—*Per cent transmission of various glasses at 302 millimicrons when new*

Trade name	Number of samples tested	Average thickness	Average transmission at 302 millimicrons
		mm.	*Per cent*
Fused quartz	1	4.7	92
Corex	4	2.8	89
Helioglass	15	2.3	56
Vitaglass	15	2.5	44
Cel-o-glass	5	[1] 1	30
Quartz-lite	16	1.9	.5
Common window glass	14	3.3	.0

[1] About.

Solarization.—Helioglass, Vitaglass, and Cel-o-glass have been found to decrease in transmission at 302 millimicrons and neighboring wave lengths (295 to 310 millimicrons) by exposure to ultra-violet radiation from the sun, quartz mercury arc, and carbon arc. The rate of change is much more rapid with the arc than with the sun and varies also with the different glasses.

Vitaglass has been on the market the longest, hence concerning this glass we are able to give the most information on solarization. A sample which had been in a hospital window in Rhode Island for a year was found to have a transmission of 25 per cent at 302 millimicrons (for thickness = 2.3 mm). Further exposure to the quartz mercury arc reduced the transmission but little, showing that solarization was complete.

Exposure in Washington of a sample ($t = 2.35$ mm) of Vitaglass directly to the sun for 123 hours (between 9 a. m. and 3 p. m. during June, July, and August) decreased the transmission from 47 to 35 per cent. Our tests show that the greatest decrease in transmission occurs during the first few weeks' exposure. The average transmission of Vitaglass at 302 millimicrons after complete degeneration by the mercury arc is about 25 per cent for a thickness of 2.3 mm.

Helioglass has not been on the market for a sufficient length of time to obtain a complete solarization test. Two samples each of Helioglass and Vitaglass, exposed simultaneously to the sun in October to December, were found to have decreased in transmission to about the same rate. The average transmission of Helioglass at 302 millimicrons, after complete degeneration by the mercury arc, is about 30 per cent for a thickness of 2.3 mm.

Corex glass appears to undergo no appreciable change in transmission when exposed to solar radiation. For example, a sample of cathedral-finish Corex which had been in a greenhouse roof in New York for 14 months was found to have, as nearly as could be measured on that kind of surface, the same transmission as a new sample. It was then polished plane and found to have a transmission of 89.5 per cent at 302 millimicrons, while the average transmission for new samples as given in Table 2 is 89. On the other hand, exposure to a quartz mercury arc causes very marked decrease in the transmission.

Cel-o-glass (cellulose acetate) becomes opaque at 302 millimicrons and shorter wave lengths after 25 hours' exposure to the quartz mercury arc. A sample that was exposed to the sun for 400 hours during the months of April to October decreased but little in transparency at 302 millimicrons. On the other hand, samples that transmitted 30 per cent at 302 millimicrons when new transmitted only 5 to 10 per cent at this wave length after being exposed on the side of a building continuously day and night for eight months, April to December, showing that the change in transparency may be owing to the varying conditions of the weather.

Quartz-lite is not appreciably affected by sunlight. Exposure to the quartz mercury arc decreases its transmission slightly (measured at 313 millimicrons).

Common window glass is also slightly decreased in transmission by exposure to the quartz mercury arc, but changes inappreciably in sunlight.

Thickness.—The thinner the glass the greater, in general, will be its transparency to ultra-violet rays. Considerations of strength, however, set a limit to an indefinite reduction in thickness. Commercial samples have been submitted for test with a thickness of less than 1 mm. (1/25 inch). In installing such glass attention should be given to the proper size of sash to meet safety requirements.

A limited number of mimeographed copies of Letter Circular No. 235, with accompanying chart showing transmission of various window glasses when new, is available at the Bureau of Standards.

Extra copies of this number of the Technical News Bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

PREPARATION OF SAGGERS ACCORDING TO FUNDAMENTAL PROPERTIES OF CLAYS

The 17 clays and the test data derived from them, which were referred to in the July, 1927, issue of the Technical News Bulletin, were made the basis for the

preparation of sagger bodies. Fifteen of these clays have been used in a total of 14 combinations of 2 clays each, 1 of high porosity and 1 of lower porosity, consideration also being given to the thermal expansion, transverse strength, and modulus of elasticity. Each combination contained the same percentage of clays and grog and was prepared with both coarse grog and fine grog, resulting in a total of 28 sagger bodies. The grog sizing and percentage of each size were as follows:

		Per cent
Coarse grog	Passed through 4 and retained on an 8 mesh sieve	20
	Passed through 8 and retained on a 12 mesh sieve	60
	Passed through 12 and retained on a 20 mesh sieve	20
Fine grog	Passed through 20 and retained on a 40 mesh sieve	66⅔
	Passed through 40 and retained on an 80 mesh sieve	33⅓

The 28 sagger bodies may be classified according to composition as follows:

Twenty-six bodies had approximately similar rates of thermal expansion. Four of these bodies contained grog prepared of that clay, in the body, which had the higher porosity, and four contained grog prepared of that clay which had the lower porosity.

Two bodies contained clays chosen on account of the dissimilarity of their rates of thermal expansion.

Six experimental oval saggers, 4 by 4 by 6 by ⅜ inches, were prepared from each of the 28 bodies and fired at 1,225° C. (cones 8½ to 9½ for one and one-half hours and were tested for their resistance to thermal shock by air quenching from progressively higher temperatures until fracture occurred. The results of the thermal shock tests indicate that (1) all saggers had failed either previous to or with the quenching at 850° C.; (2) the average failure of the bodies, containing the fine grog, occurred at a temperature approximately 100° C. lower than the bodies containing the coarse grog; (3) the two bodies, containing the clays having dissimilar rates of thermal expansion, failed at temperatures higher than was anticipated but lower than might be expected in bodies containing clays having similar rates of expansion.

It was found that grog sizing did not appreciably alter the porosity of these sagger bodies, the porosity of the saggers ranging from a minimum of 15 to a maximum of 35 per cent, regardless of whether coarse or fine grog had been used in the body.

EFFECT OF SURFACE ON ADHESION OF PLASTER TO TILE

In connection with an investigation conducted at the bureau data were developed showing the effect of the type of surface on the adhesion of plaster to hollow clay-building tile.

Three grades of tile (hard, medium, and soft) were obtained with five types of surfaces (combed, grooved, wire cut, smooth, and glazed). Each of these was plastered with a 1:3 gypsum-sanded plaster, a 1:3 cement-sand stucco, and a 1:3 cement-sand stucco with 10 per cent hydrated lime. The specimens were tested at the age of 28 days and the following results were obtained.

Tile	Surface	Average adhesion
		*Lbs./in.*²
Hard	Combed	15.0
	Grooved	15.6
Medium	Combed	15.9
	Grooved	13.2
	Wire cut	11.9
	Smooth	10.5
Soft	Combed	17.1
	Grooved	9.5

In all cases the plaster dropped from the glazed tile under its own weight.

As the only force ordinarily applied to plaster or stucco is its own weight (approximately 0.004 lb./in.² for a ½-inch coat), it is evident that the ad-

hesion of plaster or stucco to hollow-clay tile of all types is sufficiently great for safety, except in the case of a glazed tile.

A full report of this investigation appeared in the December 20, 1927, issue of the American Architect.[2]

SOLUBILITY OF LIMESTONE IN RAIN WATER

It has long been recognized that limestone as well as other carbonate rocks are slightly soluble in rain water. Attempts have heretofore been made to compare the solubility of different stones by experiments with weak acid solutions. Experiments are in progress at the bureau to determine the rate at which different types of building stones dissolve when freely exposed to the weather. Two-inch cubes of the stone are carefully weighed in the dry state and placed on the roof of one of the bureau's buildings. At intervals of a year or more they are taken into the laboratory, dried, and weighed. The limestones have shown a loss of weight of such magnitude that it can be determined readily even after one month's exposure to normal summer weather. The sandstones included in the tests indicated a very slight loss during the first two years and thereafter an increase in weight. It is probable that the loss of weight noted for sandstone was due to the leaching out of a small amount of soluble matter in the matrix, while the increase resulted from the accumulation of dust which formed on the surface.

From tests on a rather porous oolitic limestone composed mainly of calcium carbonate the loss of weight caused by seven years' exposure to the weather indicates that slightly more than 1 millimeter thickness would be dissolved from the exposed face in 100 years. Similar tests on a dense crystalline limestone indicated that the rate of erosion was about one-third less for this type.

The exposure to which these specimens were submitted is evidently much less severe than an urban exposure. The theory of this action on limestone is that rain water becomes slightly acidic from absorption of carbon dioxide and sulphurous gases from the air. Carbon dioxide in the air is more abundant in thickly populated districts and sulphurous gases more abundant in manufacturing districts where there are many smokestacks. The place of exposure of these specimens is such that one might expect relatively low amounts of these gases in the air. For this reason it is proposed to extend the experiments to more severe exposures.

The effect of surface solution on limestone used in buildings is not always undesirable. Some limestones are kept clean and fresh in appearance by this action. Limestones which do not dissolve uniformly and, hence, are left with a rough surface accumulate dirt almost as readily as a sandstone. Carvings or inscriptions on limestone freely exposed to the weather gradually lose their definition because of this action.

THERMAL EXPANSION OF ALLOYS OF THE "STAINLESS IRON" TYPE

An investigation on the thermal expansion of low-carbon iron chromium alloys of the "stainless iron" type was recently completed. No data on this subject were available. These alloys are being used to an increasing extent for various purposes, such as parts of steam turbines, devices for handling acids, and in the manufacture of other articles that must resist corrosion.

A scientific paper which gives results on the expansion of stainless iron for various temperature ranges between room temperature and 1,000° C. is now in press. Critical regions were located on some samples of stainless iron. This material expands about 17 per cent less than pure iron for the temperature range from room temperature to 100° C. The complete report will be valuable to persons interested in this material.

[2] Adhesion of plaster and stucco to hollow clay building tile, by J. A. Murray and H. D. Foster. The American Architect, p. 839; December 20, 1927.

CAST IRON FOR ENAMELING PURPOSES

The program of enameling different irons under various conditions, both at the bureau and in the laboratories of two plants, which was mentioned in an item on this subject appearing in the Technical News Bulletin for August, 1927 (No. 124), has been completed. Differences in the blistering tendencies of the different sets of castings are not so apparent in the case of the high lead enamel, but can readily be seen in the case of the higher fired, wet process enamel which was supplied to the bureau for use in this work.

Two irons were used, designated as "L" and "R." Although, on the whole, there were more blisters obtained with the L than with the R castings, yet the blistering tendencies of the castings were most consistent within the individual heats of either iron. Thus, four heats of each of these irons were made for this series of tests, and heat 4 of iron L showed distinctly less blistering tendency than the other three heats of the same iron. Similarly, heat 1 of the iron R was not as satisfactory as heats 2 and 3 of this iron. These variations may be due to irregularities in the pig iron, melting conditions, or pouring conditions, although the last two conditions were under better control than is commercially practicable.

Some interesting relationships have been found to exist in the blistering tendencies of these various sets of castings. When a surface layer of iron is removed from any of the castings studied—even those most prone to give blisters—the blistering tendency disappears. This surface layer may be removed by machining, pickling under certain conditions, or sufficiently extended sand blasting, with equally beneficial results. Data are being obtained which should indicate whether the improvement can be attributed to bodily removal of blister-producing material in the surface layer of iron or to some other cause.

A special sand-blast apparatus is in use which is capable of delivering a definite amount of sand or other abrasive at a controlled pressure. Preliminary results obtained with this apparatus indicate that those castings which have more tendency to produce blisters under ordinary conditions lose weight less readily under a given sand-blast treatment.

PROTECTION OF DURALUMIN AGAINST EMBRITTLEMENT

The trend in airplane design toward all-metal construction and extensive use of the strong, light alloy duralumin demands 100 per cent permanence and reliability of this material. Doubt has been expressed from time to time concerning the permanence of duralumin in service. Sheet duralumin has in a number of cases been seriously impaired in its properties by becoming brittle without any marked accompanying change in its surface appearance. The great bulk of sheet duralumin in use, however, has not shown evidence of such a change, and at first manufacturers of materials as well as builders and users of aircraft held the opinion that no change in the properties of duralumin takes place. However, many well-established cases of severe deterioration have been found in sheet duralumin of American and foreign manufacture. These have been shown to be the result of corrosion, the metal being attacked in a peculiar intercrystalline manner.

A cooperative investigation of this subject was conducted by the National Advisory Committee for Aeronautics, the Bureau of Aeronautics of the Navy Department, the Army Air Corps, and the Bureau of Standards. Progress reports are being issued by the National Advisory Committee for Aeronautics in its series of Technical Notes.

Intercrystalline corrosion of sheet duralumin whereby the metal becomes very brittle can be induced by accelerated laboratory tests. Chloride solutions are most effective, and the addition of an oxidizer increases the attack very decidedly. By means of such a solution, carried out as an intermittent immer-

sion test on full-size tension bars on which the strength and ductility after corrosion were determined, it has been shown that all of the aluminum alloy sheets of the duralumin type—that is, heat-treatable alloys—are subject, more or less, to intercrystalline corrosion. Heat-treated duralumins of essentially the same composition in the commercial heat-treated condition have been found to differ greatly in their corrosion resistance. Composition does not appear to be the controlling cause, although alloys containing copper as the main alloying constituent are more susceptible than those containing little or no copper.

It has not been possible by high magnification studies of the structure to obtain definite evidence as to the real "mechanism" of the intercrystalline attack. The real cause evidently is to be attributed to structural changes of a submicroscopic order. Some light has been thrown on this by X-ray analysis, but this method can not be relied upon as a sure means of distinguishing material susceptible to this form of corrosion from that which is resistant to it.

Cold-working sheet duralumin after heat treatment renders it somewhat more susceptible to intercrystalline attack. However, this appears to be only a contributory factor. Material which is heat treated by quenching from a temperature considerably below the one at which the alloy constituents are soluble in the aluminum matrix is less resistant to corrosion than if properly heat treated; that is, quenched from 500° C. and aged at room temperature several days. The rate of quenching—that is, as determined by the quenching medium used—is a very important factor. Sheet quenched in hot water was found to be very much more susceptible than cold-water quenched sheet, although the static strength properties and the visible microstructure are the same. Material which after quenching is subjected to accelerated aging—that is, aged at some elevated temperature—was also found to be much more susceptible to intercrystalline corrosion than material aged at room temperature. For a high degree of corrosion resistance in sheet duralumin (not necessarily complete freedom from attack) the material should be quenched rapidly, as in cold water, from approximately 500 to 510° C. and aged at room temperature. When exposed to the weather such materials are giving results confirming the conclusions based upon accelerated corrosion tests.

Although the resistance of sheet duralumin to intercrystalline corrosion can be greatly improved by proper heat treatment, protective coatings should also be used in order to assure complete protection. A coating of plain spar varnish is of relatively little use; when pigmented with aluminum powder, however, such a coating is greatly improved and appears entirely suitable to resist most atmospheric attacks. It is not to be relied upon for resistance to sea water, as in pontoons; a heavy bitumastic coating is suitable for this. An oxide coating made by the anodic oxidation process is of little use unless given a supplementary greasing treatment. This greatly improves such a coating, and it appears to be very suitable for atmospheric service—not for parts immersed in sea water. The anodic process appears to be the best of the oxide or related processes.

Laboratory tests have indicated that "aluminum-pigmented" rubber coatings are exceptionally well suited for the protection of dynamically stressed parts (that is, parts subjected to vibration or flexure) under very severe corrosive conditions.

Of the possible metal coatings, aluminum appears, from theoretical considerations, to be best. An aluminum coating applied by the metal-spraying process gave 100 per cent protection even under very severe corrosive conditions, and after the coated specimens (before corrosion) had been deformed (stretched). A commercial material, "Alclad," the development of which was based upon the information gained from the tests of metal-sprayed specimens, has been put on the market by one of the cooperat-

ing manufacturers. This seems to be the practical solution of the problem so far as sheet is concerned. In all cases, however, the principles established concerning the proper heat treatment (as explained previously) must be observed if a high resistance to corrosion is to be obtained.

ELECTROPLATING CONFERENCE TO BE HELD MARCH 2, 1928

A conference will be held at the Bureau of Standards on March 2 to discuss the research work on electroplating that is completed or in progress and to make recommendations regarding future studies, both by the bureau's staff and by research associates of the American Electroplaters' Society.

All persons interested in electroplating problems will be welcome at this conference; and especially the officers, committees, and members of the American Electroplaters' Society, and chemists or other representatives of those firms that have subscribed to the research fund of that society. In order that arrangements may be made for the meeting and lunch, each person expecting to attend is requested to send some form of notice to W. Blum, Bureau of Standards, Washington, D. C.

The following tentative program has been designed to include the most important items for discussion. So far as time permits, any other subjects relating to electroplating may be presented for consideration at this meeting. Such recommendations as may be made by the conference will receive the consideration of the research committee and the Bureau of Standards in deciding upon future activities.

Tentative Program

9 a. m. Inspection of the electroplating laboratories. Meet at Room 118, Chemistry Building.

10.30 a. m. Conference, Room 353, Industrial Building. W. Blum, presiding.

1. Introductory remarks.
2. Summary of published researches:
   - (a) Polarization and throwing power.
   - (b) Nickel plating.
   - (c) Zinc plating.
   - (d) Chromium plating.
   - (e) Electrotyping.

10.30 a. m. Conference, Room 353, Industrial Building. W. Blum, presiding—Continued.

3. Reports on researches in progress:
   - (a) W. P. Barrows, Spotting-out.
   - (b) M. R. Thompson, Composition and analysis of cyanides.
   - (c) H. E. Haring, Overvoltage.
   - (d) C. T. Thomas, Iron deposition
   - (e) R. O. Hull, Addition agents in copper electrotyping solutions.

1 p. m. Inspection of laboratories in Industrial Building.

1.30 p. m. Lunch, Industrial Building (75 cents).

2 p. m. Conference, Room 353, Industrial Building. R. J. O'Connor, presiding.

4. Report from the Research Committee of the American Electroplaters' Society.
5. Discussion of suggested subjects for research, including—
   - (a) Chromium plating
   - (b) Nickel plating.
   - (c) Cyanide copper plating.
   - (d) Brass plating.
6. Recommendations of conference.

TENDENCY OF MOTOR FUELS TO CAUSE DETONATION

The modern motorist is offered a variety of trade-marked gasolines by rival filling stations. The major differences between commercial gasolines are of two kinds, (a) differences in volatility and (b) differences in antiknock value. The standard distillation test, which is an important part of the Federal motor gasoline specification, enables any oil laboratory to take a cupful of gasoline and determine its relative volatility. There is no similar laboratory test for measuring the relative tendency of gasolines to knock or detonate. All that can be done at present is to compare different gasolines in an actual engine, and a survey by the Bureau of Standards shows wide differences between the equipment and methods employed by 20 different laboratories for this purpose.

The engines used include regular automobile engines, motor-cycle engines, marine engines, farm-lighting units, and specially designed single-cylinder research engines. Some of the last named are variable compression engines, and such an engine may be used to determine the compression ratio at which each fuel starts to knock—this is called the "highest useful compression ratio"—or the compression ratio at which each fuel produces its greatest power, but both these ratings vary with the particular engine used. The methods more generally used in this country depend on finding by trial the amount of tetraethyl lead which must be added to (or the percentage of benzol which must be blended with) the poorer of two fuels in order to give equal knock intensity in a particular high-compression engine under specified operating conditions. These methods involve the comparison of all unknown fuels with a standard or reference fuel and the quantity of tetraethyl lead (or benzol) required for a match is termed the tetraethyl lead (or benzol) equivalent of the unknown fuel. Such ratings by different laboratories are not readily compared because (1) each laboratory usually has its own reference fuel, and (2) test conditions vary in different laboratories.

The bureau uses a high-compression single-cylinder engine for routine knock testing and adjusts the throttle to prevent excessive detonation with each fuel. The relative power which different fuels develop under these conditions is taken as a measure of their antiknock value. Fifteen gasoline samples, submitted by refiners as typical of last winter's production, were found to range from 11 per cent worse to 30 per cent better than the U. S. motor gasoline then being furnished the Government departments under contract. Six composite gasoline samples, representing the average nonpremium gasoline sold at filling stations in various sections of the country, were also tested. The west coast sample showed the least tendency to knock, the Texas sample came next and was followed by two east coast samples. The sample from the Chicago district showed the greatest tendency to knock, but calling this 100 the Texas sample was rated 105 and the California sample 118.4.

PAPER-TESTING METHODS

The Technical Association of the Pulp and Paper Industry is actively continuing its formulation and adoption of official association paper-testing methods. This work is under the direction of B. W. Scribner, chief of the paper section of the Bureau of Standards, who acts as chairman of the formulating body, the association's paper-testing committee. The following additional 15 methods have been officially adopted by the association during the past year: Machine direction, ream weight, thickness, tearing strength and folding endurance; quantitative determination of active sulphur, moisture, ash, and starch; analysis of mineral coating and analysis of mineral filler; qualitative determination of casein, rosin, nitrogenous matter, and starch. Two other methods, opacity and gloss, have recently been completed by the committee and forwarded for the consideration of the association in respect to adoption as tentative standards. As the association has a membership of over 800 technical representatives of all branches of the paper industry, its indorsement of a paper-testing method goes a long way toward establishing it as a standard.

Another important project recently completed by the paper-testing committee is the revision of the association's publication, Paper-Testing Methods. A new edition was necessitated by the exhaustion of the present edition, there being considerable demand for this handbook of paper-testing technic. A thorough revision was considered desirable owing to the many important developments in test methods that have occurred since the previous revision in 1922. The text was largely rewritten and considerable new material was included, such as the official association methods, descriptions of 25 newly de-

veloped test methods, and 17 additional illustrations.

SELF-GOVERNMENT IN BUSINESS

Unified effort in the elimination of waste and other constructive achievements mark self-regulation and cooperation as the primary characteristics of current trade association activities. In several fields where no adequately representative association exists the desire and willingness of members of an industry to cooperate in the solution of trade problems common to them all is noticeably evident. Not infrequently groups eager to undertake cooperative efforts have found it difficult to secure results without a "coordinator" to assist them in harmonizing their views and in reaching a mutually satisfactory solution to their common problem.

In response to numerous requests for aid in such matters the Department of Commerce has certain organized services available upon request to any and all industrial or commercial groups that feel the need for a "centralizing agency" through which they can cooperate in eliminating waste through simplification and standardization. These services are afforded by the commercial standards group of the Bureau of Standards and are briefly described as follows:

The division of simplified practice assists groups desiring to reduce the number of sizes and dimensions, etc., in a common line of products. Requests received by it from any branch—producing, distributing, or consuming—are taken up with the other branches likely to be concerned or affected. When the response indicates substantial support for the proposal, the division then aids the several elements to develop, and establish their own simplified practice recommendation, and to secure maximum support for it.

The commercial standards unit similarly aids groups desiring to secure general acceptance of and support for properly established standards and specifications applying to the products of those groups. The standards which the commercial standards unit promotes are those which have been developed by the nationally recognized standards and specifications-making bodies and which the industries concerned desire to have recognized and adopted generally.

The commercial standards unit does not write specifications, neither does it make standards. Instead, it assists the several parties interested to secure maximum recognition for and use of common and mutually acceptable standards as a means of reducing unnecessary variety in grades and qualities of essential commodities.

A logical sequel to the establishment of standards of size, dimension, grade, or quality is certification to the public that the products of the industry conform to those standards. This may be accomplished by labeling the product, or otherwise advertising the fact. Provision is made for the inclusion of this feature in any simplified practice or commercial standards project, carried on under the auspices of the commercial standards group.

The commercial standards group endeavors to promote interest in and effort toward cooperative action that will result in the elimination of waste in production, distribution, and consumption of commonly used commodities. The economic advantages in waste elimination are widely known, and many industries have engaged in that field as good business. But beyond this purpose is the recognition of the fact that when industry cooperates in the public interest there is no need for legislation to protect that interest.

When an industry establishes standards of size, dimension, grade, or quality for the products of its members, and not only maintains those standards but certifies to the public its products conform to those standards, that industry is practicing self-government, and much credit is due to that industry for its endeavor. The part which the commercial standards group may play in that endeavor is merely incidental.

PACKAGING SIMPLIFICATION

Considerable interest developed during 1927 in simplification and standardization of packing and packing methods for various kinds of goods. Manufacturers of shoe boxes have indicated the need for simplification of shoe-box sizes, which, in turn, would bring about the simplification of shelving and shelf space in retail stores. Another interest in packing is the apparent need for unit packing; that is, for goods to be packed in cartons which do not have to be opened or repacked but go direct to the retailer from the producers.

The application of simplification to the packing industry may take several forms. In the case of containers for a uniform line of products (shoes) the first efforts could be made in the reduction of sizes of boxes used for the same size article. This means the establishment throughout the industry of a uniform series of sizes of boxes or containers to cover the entire range of sizes of commodity. Following this simplification, the containers or boxes could be simplified by the adoption of a uniform thickness of material used in the construction of the container. Neither program would interfere with the process of manufacture of the containers.

WOOD UTILIZATION COMMITTEE PREPARES EXHIBIT

The National Committee on Wood Utilization of the Department of Commerce prepared an exhibit of the efficient use of wood in building construction for the exposition of the Associated General Contractors of America, at West Baden, Ind., January 23 to 27. An outstanding feature was an 8-foot model of typical heavy mill construction showing details of approved construction practice.

Other exhibits showing the utilization program of the committee were end-matched lumber, short-length lumber, tie-plates and screw spikes to increase the life of railroad crossties, and preserved wood. A demonstration of lumber grades showed that the average lumber consumer is not able to check quality accurately because of existing complexity. The committee advocates the general use of lumber carrying proper quality marks placed by experts at the producing mills. Other models illustrate the proper insulation of buildings and use of penetrating acid stains to cover blemishes and minor color imperfections.

GOVERNMENT SIMPLIFIES ITS OWN FORMS

It is worthy of note, in discussing the simplification of commercial forms and papers, to observe the strict adherence by the Federal Government to the standard contract form for construction and construction or supply, promulgated November 19, 1926. These forms are used without deviation by all Government activities in connection with every form of contract for the construction or repair of public buildings or works. In addition, standard contract forms for supplies and standard Government form of contract for coal have also been tentatively completed. This illustrates the possibility of adapting one form to diverse procurement needs.

TIRE SIMPLIFIED PRACTICE RECOMMENDATION

As a result of cooperation between the manufacturers of automobile tires and the Rubber Association of America a tentative simplified practice recommendation was drafted on January 16, 1928, for the consideration of the manufacturers of automobiles. As a preliminary step in that direction the recommendation was given consideration by a convention of the Society of Automotive Engineers held in Detroit, Mich., on January 25. On that date an advisory committee composed of representatives of the automobile manufacturers, appointed by the convention, approved the purpose of the first step suggested by the recommendation; namely, the reduction in the number of balloon-tire sizes from 24 to 16. It was deemed premature to move for the adoption of the second

step; namely, a further reduction to seven sizes, inasmuch as the second step is based upon the 20-inch wheel diameter, a step which does not clearly recognize present tendencies in the industry. The advisory committee recommended that the "first revision" table be revised as follows: (1) The tire size designation shall include the tire diameter and section and the rim diameter. (2) In naming the tire size the tire diameter should be the wheel diameter plus twice the tire section. (3) The present practice of marking on the tire the rim size on which the tire is recommended for use is to be continued. (4) The present practice of measuring tire sizes on their respective rim sections is to be continued. (5) In manufacturing practice the Rubber Association of America should in measuring hold as near as possible to the section sizes. (6) The 7.00 section on the 18-inch wheel should be dropped and the 5.25 on the 18-inch rim substituted. (7) The 4.75 section on the 20-inch wheel should be dropped and the 5.25 on the 19-inch rim substituted. (8) The rim widths recommended by the Rubber Association of America are favorably considered but should be further studied by the Tire and Rim Association of America.

RECENT SIMPLIFIED PRACTICE ACTIVITIES

Revision conference on slate.—In conjunction with the annual convention of the National Slate Association held in New York on January 17 and 18 the question of revision of Simplified Practice Recommendations No. 13, Structural Slate; No. 14, Roofing Slate; and No. 15, Blackboard Slate, was taken up. The recommendation on blackboard slate was reaffirmed without change, while the recommendations for structural slate and roofing slate were modified. The industry has suggested to the division that the acceptor list in each one of the three recommendations be revised to include the individual names of all acceptors in lieu of listing only the associations. The conferees recommended that these changes be effective as of February 1, 1928, for a period of one year, subject to the regular annual revision.

Bank checks and other commercial instruments.—A meeting was held in New York on January 27 for the purpose of securing the support of manufacturers and distributors of mechanical pay-roll equipment for Simplified Practice Recommendation No. 50, Bank Checks. It was brought out in this conference that the three sizes of bank checks adopted as standard had become nationally recognized in the commercial field, and that an estimated 75 to 80 per cent of the checks in circulation were in accordance with the recommendation. A second meeting of this group is scheduled within six weeks to obtain the final decision of concerns represented at the conference.

Box board thicknesses. — Simplified Practice Recommendation No. 44 on box board thicknesses has been reaffirmed, through the standing committee of the industry, for another year, effective January 1, 1928. The results of a survey conducted by the industry at the time of the reaffirmation conference indicated 65 per cent adherence to the recommendation, which reduced the varieties from 244 to 60, an elimination of 75 per cent.

Composition books.—A general conference was held in New York City on January 31 to consider the simplification program prepared by manufacturers of composition books. The action of this conference resulted in the development of a simplified practice recommendation for this type of stationery. Manufacturers, distributors, and users will be circularized in the near future for acceptance to the program.

Lead pencils.—On January 10 a preliminary conference was held at the Stationers and Publishers Board of Trade in New York, in connection with the development of a program for the simplification of lead pencils. This meeting was attended by manufacturers, who have been conducting a survey of the

existing variety with a view to effecting a reduction in the number now offered and to the development of a simplified practice recommendation.

Hollow metal and kalamein doors.—On January 25 there was held at the Department of Commerce a joint general conference on the simplification of hollow metal and kalamein doors. This conference adopted two simplified-practice recommendations—one for hollow metal doors and one for kalamein doors. The one for kalamein doors provides for 4 stock door sizes, 5 semistock single doors, and 5 semistock sizes for resultant pairs, while the recommendation for hollow metal doors provides for 9 sizes for single doors and the same for the resultant pairs.

Form dimensions for concrete-ribbed floor construction.—The tentative simplified practice recommendation on this subject, which was circularized to a representative group of manufacturers, distributors, and users, has met with general approval. Such criticisms as have been offered are minor in character. It is expected that a general conference will be held about the middle of March.

Hospital plumbing fixtures.—At the third preliminary conference of manufacturers of vitreous china, solid porcelain, and enameled-iron plumbing fixtures, held at the Department of Commerce on January 11, a tentative simplified practice recommendation was developed covering over-all dimensions for hospital plumbing fixtures. The schedule is now before the hospital authorities for their review and recommendation as to definite sizes and heights considered best adapted to hospital use.

Jam jars and jelly glasses.—On January 4 the National Preservers Association initiated a survey of present practice in the use of jars and glasses, in so far as sizes and capacities are concerned. A composite report, including the views of individual preservers, will finally be presented to a general conference of the whole industry for its consideration and adoption as a simplified practice recommendation.

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1927)

Scientific Papers [3]

S564. Absolute measurement of capacitance by Maxwell's method; H. L. Curtis and Charles Moon. Price, 15 cents.

S566. Indeterminateness of electrical charge; Chester Snow. Price, 5 cents.

Title page and index for volume 21 of Scientific Papers, Nos. 524 to 546, inclusive (free on application to Bureau of Standards).

Circulars [3]

C197 (2d ed.). United States Government Master Specification for ink, marking, indelible, for fabrics. Price, 5 cents.

Simplified Practice Recommendations [3]

SPR69. Packaging of razor blades. Price, 5 cents.

Miscellaneous Publications [3]

M79. Standards and specifications in the wood-using industries. Price, $1.50.

Technical News Bulletin [3]

TNB130. Technical News Bulletin, February, 1928.

OUTSIDE PUBLICATIONS [4]

Studying corroding action of soils. H. D. Holler; Oil and Gas Journal (Tulsa, Okla.), Vol. 26, No. 32, p. 46; December 29, 1927.

An adaptation of the thermal conductivity method to the analysis of respiratory gases. P. G. Ledig and R. S. Lyman; Journal of Clinical Investigation (Baltimore, Md.), Vol. IV, No. 4, p. 495; October 20, 1927.

[3] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

[4] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

Cigarettes and cigars, fire-hazard tests. P. D. Sale and F. M. Hoffheins; Quarterly of the National Fire Protection Association (Boston, Mass.), Vol. 21, No. 3, p. 237; January, 1928.

A method for measuring the color of textiles. W. D. Appel; American Dyestuff Reporter (New York, N. Y.), p. 49; January 23, 1928.

Leather work at the Bureau of Standards. R. C. Bowker; Leather Manufacturer (Boston, Mass.), Vol. XXXIX, p. 11; January, 1928.

Paper research at United States Bureau of Standards during 1927. B. W. Scribner; Paper Trade Journal (New York, N. Y.), Vol. 86, No. 4, p. 52; January 26, 1928.

Protective metallic coatings. H. S. Rawdon; book of 277 pages, published by Chemical Catalogue Co., New York, N. Y. American Chemical Society Monograph Series, No. 40.

Wear testing of metals. H. J. French; Proceedings, American Society for Testing Materials (Philadelphia, Pa.), Vol. 27, No. 2, p. 213; 1927.

Preliminary report on comparative high-temperature tests on a carbon and on a chrome-molybdenum steel at different laboratories. L. W. Spring, C. Upthegrove, H. J. French; Proceedings, American Society for Testing Materials (Philadelphia, Pa.), Vol. 27, No. 1, p. 143; 1927.

Report on corrosion of nonferrous metals and alloys. T. S. Fuller, Chairman, Committee B-3, American Society for Testing Materials (Philadelphia, Pa.), Vol. 27, No. 1, p. 281; 1927.

Etching reagents for carbides in alloy steels. E. C. Groesbeck; Proceedings, American Society for Testing Materials (Philadelphia, Pa.), Vol. 27, No. 1, p. 603; 1927.

Laying the hard copper ghost. Reprint of Bureau of Standards Letter Circular No. 61; Foundry (Cleveland, Ohio), Vol. 56, p. 71; 1928.

Some observations on the dehydration and firing behavior of clays. R. F. Geller and W. H. Wadleigh; Journal, American Ceramic Society (Columbus, Ohio), Vol. 10, No. 12, p. 925; December, 1927.

A petrographic study of some slags from boiler furnaces. S. J. McDowell and H. C. Lee; Journal, American Ceramic Society (Columbus, Ohio), Vol. 11, No. 1, p. 35; January, 1928.

Adhesion of plaster and stucco to hollow building tile; J. A. Murray and H. D. Foster; Brick and Clay Record (Chicago, Ill.), Vol. 72, No. 1, p. 34; January, 1928.

Gypsum investigations during 1927 by the Bureau of Standards. Lime and gypsum section's staff. Pit and Quarry (Rand McNally Building, Chicago, Ill.), Vol. XV, No. 7, p. 65; January 4, 1928.

Bureau of Standards investigations on lime during 1927. Lime and gypsum section's staff; Pit and Quarry (Rand McNally Building, Chicago, Ill.), Vol. XV, No. 7, p. 81; January 4, 1928.

Cement, lime, gypsum, and stone at the Bureau of Standards in 1927; Ceramic division's staff; Rock Products (Chicago, Ill.), Vol. 31, No. 1, p. 57; January 7, 1928.

The strength of solid and of hollow brick walls. A. H. Stang; Ceramic Age (New Brunswick, N. J.), Vol. X, No. 6, p. 198; December, 1927.

Wave mechanics. Paul R. Heyl; Scientific Monthly (New York, N. Y.), Vol. XXVI, p. 41; January, 1928.

Wonderlands of to-morrow. H. D. Hubbard; The Valve World (Crane Company, Chicago, Ill.), Vol. XXIV, No. 1, p. 25; January, 1928.

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